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Predicted Weights and Volumes of Southern Red Oak Trees on the Highland Rim in Tennessee

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Conversion factors: English to metric

<i>Multiply</i>	<i>By</i>	<i>To obtain</i>
Inches	2.540	centimeters
Feet	.3048	meters
Pounds	.4536	kilograms
Cubic feet	.02832	cubic meters
Pounds per cubic foot	16.02	kilograms per cubic meter

All English units of measure in this report can be converted to metric units by multiplying by the appropriate conversion factor listed above.

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Predicted Weights and Volumes of Southern Red Oak Trees on the Highland Rim in Tennessee¹

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ABSTRACT.—Total weights and volumes, above stump, were determined for 29 southern red oak (*Quercus falcata* Michx.) trees 5 to 22 inches d.b.h. growing on the Highland Rim in Tennessee. Equations are presented for predicting green and dry weights and green volume of the total tree and its components using d.b.h. and total height, d.b.h. and height to a 4-inch top, d.b.h. and saw-log merchantable height, and d.b.h. alone. Tables developed from equations show weight and volume of the total tree and its components by d.b.h. and total height classes. Seventy percent of the average tree's green weight was in stem material to a 4-inch top, and 30 percent was in crown material. Total-tree wood had an average specific gravity of 0.604, average moisture content of 74 percent, and average green weight per cubic foot of 66 pounds. The weight of wood and bark averaged 81 pounds per cubic foot of wood for the total tree.

Keywords: *Quercus falcata* Michx., biomass, component proportions, equations, specific gravity, moisture content, weight per cubic foot.

Increasing demands for wood, escalating costs, and the energy shortage have forced forest industries in the South to consider utilizing all parts of trees. Utilizing the total tree above the stump compared to utilizing only the merchantable stem can increase yields from individual hardwood trees by 10 to 65 percent (Clark 1978). Equations for estimating total-tree weight and volume are needed to evaluate and utilize total trees.

This Paper presents green volumes and green and dry weights of above-stump biomass of commercial-size southern red oaks (*Quercus falcata* Michx.) growing in an uneven-aged stand in south-central Tennessee. Equations and yield tables predict weight and volume of the total tree

and its components (wood, bark, saw logs, stem, and crown). Wood and bark specific gravity, moisture content, and green weight per cubic foot are presented for the total tree and its components.

PROCEDURE

Field

A stratified random sample of 29 southern red oak trees was selected from a natural, fully stocked, uneven-aged stand of mixed oaks. The stand had an average site index for southern red oak of 70 and was located on the Highland Rim in Coffee County, Tennessee. Four trees were selected from each of seven d.b.h. classes at 2-inch intervals from 6 to 18 inches, and one tree was chosen from the 22-inch class. Form class of the sawtimber trees ranged from 70 to 82 and averaged 75. The trees sampled ranged from 37 to 100 years of age and averaged 62 years. Means and ranges of tree measurements are shown in table 1.

¹This study was conducted in cooperation with and through the financial assistance of the Division of Land and Forest Resources, Tennessee Valley Authority, Norris, Tennessee. Cooperation and assistance were also received from the Arnold Engineering Development Center, Tullahoma, Tennessee.

Table 1.—Means and ranges in dimensions of southern red oak trees sampled in Coffee County, Tennessee, by d.b.h. class

D.b.h. class (inches)	Sample trees	D.b.h.		Total height		Height to 4-inch d.i.b. top		Height to saw-log merchantable top ^a		D.o.b. at saw-log merchantable top	
		Average	Range	Average	Range	Average	Range	Average	Range	Average	Range
	<i>Number</i>	<i>..... Inches</i>		<i>..... Feet</i>				<i>..... Inches</i>			
6	4	6.2	5.4– 6.7	54	53–55	19	13–25	—	—	—	—
8	4	8.3	7.7– 8.7	62	56–66	37	28–43	—	—	—	—
10	4	9.9	9.5–10.2	72	66–80	45	39–54	—	—	—	—
12	4	12.0	11.3–12.8	70	68–72	48	45–52	21	18–26	9.5	8.6–10.6
14	4	14.6	14.1–14.9	71	69–74	51	48–55	21	18–28	11.8	11.4–12.5
16	4	16.1	15.2–16.7	76	72–77	55	54–56	22	19–27	13.4	12.2–14.6
18	4	18.2	17.5–18.6	80	77–84	61	57–65	32	27–35	13.9	12.3–14.8
20	0	—	—	—	—	—	—	—	—	—	—
22	1	22.0	—	81	—	63	—	23	—	16.9	—
All classes	29	12.5	5.4–22.0	70	53–84	45	13–65	24	18–35	12.4	8.6–16.9

^aHeight to 8-inch d.i.b. or saw-log merchantable top.

Trees were felled and limbed during the winter, and the main stem of each tree was bucked into merchantable saw logs and pulpwood. Saw logs 8 to 18 feet long were cut from the main stem to an 8-inch d.i.b. top or to a degrading quality indicator such as large knots. Stem d.o.b. to the saw-log top averaged 12.4 inches (table 1). All material between the saw-log merchantable top and the 4-inch d.i.b. top was classed as "pulpwood." All trees had a discernible main stem to a 4-inch top. Material between the 4- and 2-inch d.i.b. top was classed as "topwood." The crown was cut up and separated into four categories: (extra large branches (≥ 4.0 inches d.o.b.), (2) large branches (≥ 2.0 and < 4.0 inches d.o.b.), (3) medium branches (≥ 0.6 inches and < 2.0 inches d.o.b.), and (4) small branches (≤ 0.5 inches d.o.b.). The tip of the stem (2 inches to top) was included as branch material in the analysis. Dead branches were cut from the bole and weighed separately. All crown material and pulpwood were weighed to the nearest quarter of a pound. Saw logs were weighed individually to the nearest pound.

Disks were removed from the butt of each sawtimber tree (trees ≥ 11.0 inches d.b.h.); at each saw-log bucking point; at the points where d.i.b. measured 8, 6, 4, and 2 inches; and from branches randomly selected from each branch-size category. In pulpwood-size trees (trees 5.0 to

10.9 inches d.b.h.), disks were cut from the butt of each tree, at quarter points to a 4-inch top, and where d.i.b. measured 2.0 inches. Each disk was sealed in a polyethylene bag for subsequent laboratory determinations of moisture content, specific gravity, and bark percent.

Laboratory

Specific gravity was computed on a green-volume and oven-dry-weight basis. Moisture content was computed on an oven-dry-weight basis after samples were dried to a constant weight at 103° C. Percentage of bark was determined from disks on a green-weight basis. Moisture content, specific gravity, and percentage of bark in the stem, branches, and the total tree were calculated by weighting disk values in proportion to the volume of the component they represented. Weighted values for moisture content were used to convert component green weight to oven-dry weight.

Green weights per cubic foot of wood and bark were calculated from weighted values for specific gravity and moisture content with the equation:

Green weight per cubic foot

$$= \left[1 + \frac{M.C.}{100} \right] \times (S.G.) \times (C) \quad (1)$$

where:

M.C. = weighted moisture content in percent
 S.G. = weighted specific gravity,
 C = 62.4 pounds (weight of water per cubic foot).

Cubic-foot volumes of green wood and bark were computed by dividing component weight by its green weight per cubic foot. Total green cubic-foot volume (wood and bark combined) was computed by adding the green volume of wood to the green volume of bark.

Analysis

Linear regression equations were developed to predict green and dry weights and green volumes of wood and bark in the total tree and its components. Independent variables were: diameter at breast height (D), total height (Th), saw-log merchantable height (Mh), and height to a 4-inch top (H4), both separately and in various combinations.

Grouping the data into D²Th classes and plotting the variance of Y over D² and D²Th indicated that the variance of predicted weights and volumes increased with increasing D² and D²Th. A logarithmic transformation (to the base 10) was used to obtain a relatively homogeneous variance, which is assumed in regression analysis. Thus, regression equations for tree and component weights and volumes were calculated using the equations:

$$\text{Log } Y = b_0 + b_1 \text{ Log } X + \epsilon \quad (2)$$

$$\text{Log } Y = b_0 + b_1 \text{ Log } X_1 + b_2 \text{ Log } X_2 + \epsilon \quad (3)$$

where:

Y = weight or volume of component,
 X = D², D²Th, D²H4, or D²Mh,
 X₁ = D²
 X₂ = Th, H4, or Mh,
 ε = sampling error,
 b_i = regression coefficients.

When logarithmic estimates are converted back to original units, they are biased downward because the antilogarithm of an estimated mean gives the geometric rather than the arithmetic mean (Cunia 1964). To account for this bias, a correction factor was computed using a procedure described by Baskerville (1972) and ap-

plied to each equation. The forms of the equations, including the correction factor, are:

$$Y = 10^{b_0 + b_1 \log X + \frac{S^2_{y \cdot x}}{2}} \quad (4)$$

and

$$Y = 10^{b_0 + b_1 \text{ Log } X_1 + b_2 \log X_2 + \frac{S^2_{y \cdot x}}{2}} \quad (5)$$

where:

S²_{y·x} = error mean square from regression analysis

Equations (4) and (5) were simplified to:

$$Y = aX^{b_1} \quad (6)$$

and

$$Y = aX_1^{b_1}X_2^{b_2} \quad (7)$$

where:

$$a = 10^{b_0 + \frac{S^2_{y \cdot x}}{2}}$$

SAMPLE TREE CHARACTERISTICS

Total Tree

Green weight of the trees sampled ranged from an average of 279 pounds for 6-inch trees to 7,681 pounds for the 22-inch tree. Assuming the trees were composed solely of wood, bark, and water, 41 percent of their green weight was water; 46 percent was wood; and 13 percent was bark. The proportions of total-tree weight in wood and bark did not vary with tree size. The proportion of tree weight in bark ranged from 19 to 21 percent, averaging 19 percent on a green basis. This is slightly higher than the averages reported for northern red oak (*Q. rubra* L.) (15 percent) (Clark and others, in press) and scarlet oak (*Q. coccinea* Muenchh.) (16 percent) (Clark and others, in press). Wood made up an average of 78 percent of total-tree dry weight, and bark 22 percent.

The proportion of green weight in crown material (all live branches and topwood) ranged from 17 to 44 percent but did not vary consistently with tree size. The proportion of green weight in the stem to a 4-inch top averaged 70 percent; the proportion in crowns averaged 30 percent. Sixty-eight percent of the tree's dry weight was in stem material and 32 percent was in crown material.

The proportion of total-tree green weight in dead branches ranged from 0 to 1 percent and averaged 0.8 percent.

The green and dry weights of all wood and bark in the tree and the distribution of wood and bark throughout the tree are presented in tables 2 and 3. On the average, pulpwood-size trees had 73 percent of their total green wood weight in the stem to a 4-inch d.i.b. top and 27 percent in the crown. Sawtimber trees on the average had 72 percent of their green wood weight in the stem to a 4-inch top and 28 percent in the crown. Forty-six percent of their green wood weight was saw-log material and 26 percent was pulpwood.

Wood and bark are not distributed evenly throughout the tree. For example, the stem to a

4-inch top of the average sawtimber tree contained 72 percent of all the green wood in the tree but only 59 percent of the bark. On the other hand, branches contained 28 percent of the green wood and 41 percent of the bark. The proportion of green wood in branches generally increased with increasing tree size, ranging from 15 percent in pulpwood trees to 27 percent in sawtimber trees. The proportion of total-tree green bark weight in branches also increased with tree size, ranging from 22 percent in pulpwood trees to 40 percent in sawtimber trees.

Table 2.—Average green and dry weight of wood in the total tree and its distribution in the main stem^a and live branches in southern red oak trees

D.b.h. class (inches)	Average total height	Sample trees	Total- tree wood weight	Proportion of wood in—								
				Main stem				Live branches (inches d.o.b.)				
				Saw- log ^b	Pulp- wood ^c	Top- wood	Total stem	≥ 4	< 4 & ≥ 2	< 2 & > 0.5	≤ 0.5	All branches
	<i>Feet</i>	<i>Number</i>	<i>Pounds</i>	<i>Percent</i>								
GREEN PULPWOOD												
6	54	4	275	—	57	24	81	—	5	12	2	19
8	62	4	584	—	77	7	84	—	2	12	2	16
10	72	4	845	—	85	5	90	—	4	6	1	10
Average	—	—	568	—	73	12	85	—	3	10	2	15
GREEN SAWTIMBER												
12	70	4	1,650	53	28	2	83	3	8	7	1	17
14	71	4	2,475	42	28	1	71	7	12	9	1	29
16	76	4	3,339	43	29	1	73	8	11	7	1	27
18	80	4	4,576	52	19	1	72	12	9	6	1	28
20	—	—	—	—	—	—	—	—	—	—	—	—
22	81	1	6,250	39	28	1	68	14	8	9	1	32
Average	—	—	3,201	46	26	1	73	10	9	7	1	27
DRY PULPWOOD												
6	54	4	160	—	56	24	80	—	8	14	3	21
8	62	4	350	—	76	7	82	—	2	13	2	17
10	72	4	488	—	84	6	89	—	6	7	1	11
Average	—	—	333	—	72	12	84	—	5	10	2	16
DRY SAWTIMBER												
12	70	4	949	52	28	2	82	3	8	8	1	18
14	71	4	1,415	40	28	1	69	8	12	10	1	31
16	76	4	1,896	41	28	1	71	8	12	8	1	29
18	80	4	2,559	50	19	1	70	12	10	7	1	30
20	—	—	—	—	—	—	—	—	—	—	—	—
22	81	1	3,530	37	27	1	65	15	9	10	1	35
Average	—	—	1,812	45	25	1	71	11	11	8	1	31

^aMain stem to 2-inch d.i.b. top.

^bSaw logs to 8-inch d.i.b. or saw-log merchantable top.

^cPulpwood in stem from butt or saw-log top to 4-inch d.i.b. top.

Table 3.—Average green and dry weight of bark in the total tree and its distribution in the main stem^a and live branches in southern red oak trees

D.b.h. class (inches)	Average total height	Sample trees	Total- tree bark weight	Proportion of bark in—								
				Main stem				Live branches (inches d.o.b.)				
				Saw- log ^b	Pulp- wood ^c	Top- wood	Total stem	≥ 4	< 4 & ≥ 2	< 2 & > 0.5	≤ 0.5	All branches
<i>Feet Number Pounds Percent</i>												
GREEN PULPWOOD												
6	54	4	66	—	52	23	74	—	6	18	4	26
8	62	4	140	—	69	7	76	—	3	17	4	24
10	72	4	215	—	77	7	84	—	6	10	2	16
Average	—	—	140	—	66	12	78	—	5	14	3	22
GREEN SAWTIMBER												
12	70	4	394	42	28	3	73	4	12	11	2	26
14	71	4	640	33	24	1	59	8	16	13	2	41
16	76	4	765	34	24	1	60	10	15	12	3	40
18	80	4	1,041	40	17	1	57	15	14	11	2	29
20	—	—	—	—	—	—	—	—	—	—	—	—
22	81	1	1,431	32	24	1	56	17	12	12	3	44
Average	—	—	752	37	22	1	60	13	14	11	2	40
DRY PULPWOOD												
6	54	4	42	—	55	21	76	—	5	17	5	24
8	62	4	96	—	71	7	77	—	2	16	4	22
10	72	4	149	—	78	7	86	—	5	9	2	14
Average	—	—	97	—	68	12	80	—	4	13	3	20
DRY SAWTIMBER												
12	70	4	273	43	29	3	75	4	12	10	2	25
14	71	4	439	34	25	1	60	9	16	12	2	40
16	76	4	521	35	25	1	61	10	15	11	2	39
18	80	4	709	41	17	1	58	15	14	10	2	41
20	—	—	—	—	—	—	—	—	—	—	—	—
22	81	1	982	33	25	1	58	18	11	11	2	42
Average	—	—	515	37	23	1	61	13	14	10	2	39

^aMain stem to 2-inch d.i.b. top.

^bSaw logs to 8-inch d.i.b. or saw-log merchantable top.

^cPulpwood in stem from butt or saw-log top to 4-inch d.i.b. top.

Stem Components

The main stem to a 4-inch top had 84 percent of its green weight in wood and 16 percent in bark, while 80 percent of the dry stem weight was wood and 20 percent bark. The proportion of stem weight in wood and bark did not vary with tree size.

Crown Components

The proportion of crown green weight in bark ranged from 21 to 29 percent but did not vary

consistently with tree size. The proportion of crown green weight in wood averaged 74 percent and in bark it averaged 26 percent. The proportions averaged 72 and 27 percent, respectively, on a dry basis. For branches, the proportion of green weight in bark increased with decreasing branch size. Branches ≥ 4 inches had 23 percent of their weight in bark, while branches ≤ 0.5 inches d.o.b. had 33 percent of their weight in bark. Dead branches comprised 3 percent of total crown green weight.

The change in distribution of crown materials with increasing tree size is shown in figure 1.

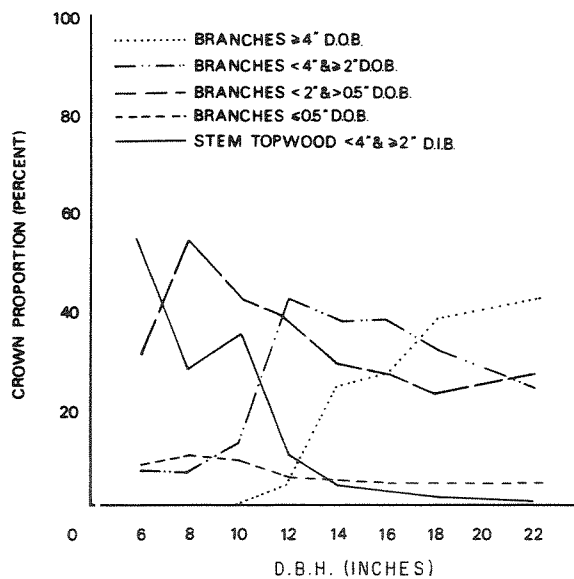


Figure 1.—Proportions of southern red oak crown green weight in topwood and branches, by d.o.b.-size classes.

Physical Properties

Wood and bark specific gravity, moisture content, and green weight per cubic foot for the total tree and its components are presented in

table 4. Wood specific gravity and moisture content did not vary significantly with tree size. Specific gravity averaged 0.604 for the total tree and 0.587 for the total stem—higher than the average of 0.52 reported for southern red oak stem wood (Forest Products Laboratory 1974). Branches had the highest specific gravity, averaging 0.659, and saw-log wood the lowest, averaging 0.587. Average moisture content of wood ranged from 60 percent in the branches to 81 percent in saw logs and averaged 74 percent for all wood in the tree. Green weight per cubic foot averaged 65 pounds in the main stem and 66 pounds in the branches and total tree.

Specific gravity of bark was lowest in branches (0.606) and highest in the pulpwood section of the main stem (0.668). Bark specific gravity in the total tree averaged 0.642—higher than the corresponding wood specific gravity value. Bark moisture content for the total tree averaged 47 percent, which was lower than the corresponding value for wood. Branch bark moisture content was the highest, averaging 55 percent, and pulpwood bark was the lowest, averaging 43 percent. Average green bark weight per cubic foot ranged from 58 pounds for branches to 62 pounds for the

Table 4.—Average wood and bark specific gravity, moisture content, and green weight per cubic foot for southern red oak trees and tree components

Tree component	Average and standard deviation		
	Specific gravity	Moisture content	Green weight per cubic foot
		<i>Percent</i>	<i>Pounds</i>
WOOD			
Total tree	0.604 ± 0.021	74 ± 5.8	66 ± 1.5
Stem (butt to 4-inch d.i.b. top)	.587 ± .022	79 ± 7.0	65 ± 1.5
Saw log (butt to 8-inch d.i.b. top)	.587 ± .022	81 ± 6.6	66 ± 1.7
Pulpwood (8- to 4-inch d.i.b. top)	.602 ± .023	72 ± 4.8	65 ± 1.8
Topwood (4- to 2-inch d.i.b. top)	.633 ± .033	65 ± 3.7	65 ± 2.6
Branches	.659 ± .024	60 ± 4.2	66 ± 1.8
BARK			
Total tree	0.642 ± 0.035	47 ± 4.7	59 ± 2.6
Stem (butt to 4-inch d.i.b. top)	.652 ± .042	44 ± 3.9	58 ± 3.0
Saw log (butt to 8-inch d.i.b. top)	.651 ± .046	44 ± 4.3	58 ± 3.1
Pulpwood (8- to 4-inch d.i.b. top)	.668 ± .042	43 ± 4.0	60 ± 3.5
Topwood (4- to 2-inch d.i.b. top)	.667 ± .031	48 ± 7.0	62 ± 3.5
Branches	.606 ± .044	55 ± 5.1	58 ± 3.2

topwood section and averaged 59 pounds for the total tree.

The weight of wood and bark per unit volume of wood is a useful factor for estimating the volume of wood in a tree or its components when weight with bark is known. The average green weight of wood and bark per cubic foot of wood was 81 pounds for the total tree and 79 pounds for the stem (table 5). For branch material, the green weight of wood and bark per cubic foot of wood averaged 88 pounds and was considerably higher than the average for the main stem, because branches contain 38 percent more of their weight in bark.

Green weight per cubic foot of wood and bark combined averaged 64 pounds for the total tree, stem, and branch material (table 5).

and D^2H4 as the independent variable. When D^2 and Mh were used as separate variables in equation (3), the coefficient of determination (R^2) increased 15 to 20 percent and the standard error was reduced. Thus, the two-variable model was used when D^2 and Mh were the independent variables.

All independent variable combinations were good predictors of weights and volumes, but equations using D^2Th were the best for total-tree values. These equations had slightly higher coefficients of determination and slightly lower standard errors of estimates than the equations using D^2 , D^2H4 , or $D^2 + Mh$.

Equations using $D^2 + Mh$ were the best estimators of saw-log merchantable stem weight and volume, while equations using D^2H4 were the

Table 5.—Average green weight of wood and bark per cubic foot of wood and average green weight of wood and bark per cubic foot of wood and bark for southern red oak trees and tree components

Tree component	Average and standard deviation	
	Green weight of wood & bark per cubic foot of wood	Green weight of wood & bark per cubic foot of wood & bark
	..... Pounds	
Total tree	81 ± 1.9	64 ± 1.5
Stem (butt to 4-inch d.i.b. top)	79 ± 1.9	64 ± 1.6
Saw log (butt to 8-inch d.i.b. top)	79 ± 1.8	65 ± 1.3
Pulpwood (8- to 4-inch d.i.b. top)	82 ± 3.8	64 ± 1.8
Topwood (4- to 2-inch d.i.b. top)	87 ± 6.6	64 ± 2.6
Branches	88 ± 4.3	64 ± 1.6

PREDICTION EQUATIONS

A series of equations was developed to predict weights and volumes of total trees and their components. Since heights of trees are measured to different top limits by various organizations, equations were developed using D^2 alone and in combination with Th , $H4$, and Mh separately and combined as independent variables. When D^2 and Th or D^2 and $H4$ were used, the one-variable equation (2) and the two-variable equation (3) predicted total-tree and component weights and volumes equally well. The use of height as a separate variable did not improve the coefficient of determination or reduce the standard error. Thus, the single-variable model was used to predict tree weight and volume when using D^2 , D^2Th ,

best predictors of stem weight and volume to a 4-inch top. When average tree heights and stem taper for d.b.h. classes are similar to those of our sample trees, the equations using d.b.h. alone will result in good estimates of tree weight and volume. However, when average tree heights by d.b.h. classes are different, the equations that include a height variable should be applied directly or used to develop local weight-volume tables based on d.b.h. alone.

Appendix tables 6 and 7 present equations for predicting all weights and volumes measured from D^2Th . Appendix tables 8 and 9 present equations that use D^2 , D^2H4 , and $D^2 + Mh$ to predict the green weights of wood and bark and volumes of wood for selected tree components of greatest interest. The Appendix also describes a method

for placing confidence limits on predictions made with the equations.

A complete list of equations based on D^2 , D^2H^4 , and D^2Mh for predicting the green and dry weights and volumes of wood and bark in all tree components listed in tables 6 and 7 is available from the authors at the Southeastern Forest Experiment Station, Forestry Sciences Laboratory, Carlton Street, Athens, Georgia 30602. Also available are uncorrected sums and sums of squares and their cross products for the independent and dependent variables listed in tables 6 and 7. These data make it possible to compare and combine equations statistically. They also allow for the addition of observations and for computation of error terms.

BIOMASS TABLES

Equations based on D^2Th from tables 6 and 7 were used to develop tables of biomass weight and volume. Tables 10-13 show predicted green weight of wood and bark and wood alone in the total tree, the saw-log stem to an 8-inch d.i.b. or saw-log merchantable top, the stem to a 4-inch d.i.b. top, and the crown. Tables 14-17 show predicted green volumes of wood and bark and wood alone in the total tree and its components. The predicted weight or volume of bark in a tree or component can be estimated by subtracting the value in the table for wood alone from the corresponding value in the table for wood and bark combined.

Similar-sized trees may vary in weight and volume because of differences in crown size, stem

taper, and weight per cubic foot. Therefore, the equations and tables should be applied only to trees growing in natural, fully stocked stands which have stem taper rates and weights per cubic foot similar to the trees sampled.

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APPENDIX

Table 6.—Regression equations for estimating above-stump green and dry weights of the total tree and its components for southern red oak trees 5 to 22 inches d.b.h., using d.b.h. and total height as independent variables

Weight (Y)	Regression equation ^a	Coefficient of determination (R ²)	Standard error ^b (S _{y·x}) ^c	Number trees sampled (N)
Total tree (excluding foliage):				
Green weight	Y = 0.06632 (D ² Th) ^{1.11245}	0.98	0.0538	29
Dry weight	Y = 0.04381 (D ² Th) ^{1.10112}	.98	.0560	29
All wood in tree:				
Green weight	Y = 0.05262 (D ² Th) ^{1.11420}	.98	.0571	29
Dry weight	Y = 0.03565 (D ² Th) ^{1.09624}	.98	.0623	29
All bark in tree:				
Green weight	Y = 0.01378 (D ² Th) ^{1.10452}	.98	.0540	29
Dry weight	Y = 0.00834 (D ² Th) ^{1.11743}	.98	.0545	29
Wood and bark in stem from stump to saw-log merchantable top (trees ≥ 11.0 inches d.b.h.):				
Green weight	Y = 0.23227 (D ² Th) ^{0.90557}	.73	.1020	17
Dry weight	Y = 0.17670 (D ² Th) ^{0.87631}	.71	.1038	17
Wood in stem from stump to saw-log merchantable top (trees ≥ 11.0 inches d.b.h.):				
Green weight	Y = 0.16578 (D ² Th) ^{0.92239}	.73	.1044	17
Dry weight	Y = 0.12366 (D ² Th) ^{0.89071}	.70	.1086	17
Bark in stem from stump to saw-log merchantable top (trees ≥ 11.0 inches d.b.h.):				
Green weight	Y = 0.08607 (D ² Th) ^{0.81733}	.70	.1000	17
Dry weight	Y = 0.06024 (D ² Th) ^{0.81841}	.70	.1002	17
Wood and bark in stem from stump to 8-inch d.i.b. top (trees ≥ 11.0 inches d.b.h.):				
Green weight	Y = 0.08870 (D ² Th) ^{1.03856}	.96	.0404	17
Dry weight	Y = 0.06746 (D ² Th) ^{1.00930}	.95	.0421	17
Wood in stem from stump to 8-inch d.i.b. top (trees ≥ 11.0 inches d.b.h.):				
Green weight	Y = 0.06330 (D ² Th) ^{1.05538}	.95	.0446	17
Dry weight	Y = 0.04720 (D ² Th) ^{1.02370}	.94	.0503	17
Bark in stem from stump to 8-inch d.i.b. top (trees ≥ 11.0 inches d.b.h.):				
Green weight	Y = 0.03327 (D ² Th) ^{0.95033}	.95	.0427	17
Dry weight	Y = 0.02302 (D ² Th) ^{0.95140}	.95	.0426	17
Wood and bark in stem from stump to 4-inch d.i.b. top:				
Green weight	Y = 0.03062 (D ² Th) ^{1.15873}	.98	.0607	29
Dry weight	Y = 0.02132 (D ² Th) ^{1.13946}	.98	.0665	29
Wood in stem from stump to 4-inch d.i.b. top:				
Green weight	Y = 0.02324 (D ² Th) ^{1.16832}	.98	.0604	29
Dry weight	Y = 0.01627 (D ² Th) ^{1.14398}	.98	.0681	29
Bark in stem from stump to 4-inch d.i.b. top:				
Green weight	Y = 0.00812 (D ² Th) ^{1.11044}	.97	.0787	29
Dry weight	Y = 0.00519 (D ² Th) ^{1.11995}	.97	.0825	29

Continued

Table 6.—Regression equations for estimating above-stump green and dry weights of the total tree and its components for southern red oak trees 5 to 22 inches d.b.h., using d.b.h. and total height as independent variables—Continued

Weight (Y)	Regression equation ^a	Coefficient of determination (R ²)	Standard error ^b (S _{y·x}) ^c	Number trees sampled (N)
Wood and bark in crown (all branches and topwood < 4 inches d.i.b.):				
Green weight	$Y = 0.02596 (D^2Th)^{1.07671}$	.83	.1930	29
Dry weight	$Y = 0.01531 (D^2Th)^{1.08312}$	.83	.1904	29
Wood in crown (all branches and topwood < 4 inches d.i.b.):				
Green weight	$Y = 0.02292 (D^2Th)^{1.05855}$	.80	.2053	29
Dry weight	$Y = 0.01417 (D^2Th)^{1.05815}$	.80	.2035	29
Bark in crown (all branches and topwood < 4 inches d.i.b.):				
Green weight	$Y = 0.00376 (D^2Th)^{1.13674}$	.88	.1615	29
Dry weight	$Y = 0.00197 (D^2Th)^{1.16047}$	.89	.1627	29
Wood and bark in crown ≥ 2.0 inches d.o.b.:				
Green weight	$Y = 0.00394 (D^2Th)^{1.22418}$	.77	.2584	29
Dry weight	$Y = 0.00220 (D^2Th)^{1.23551}$	.78	.2541	29
Wood in crown ≥ 2.0 inches d.o.b.:				
Green weight	$Y = 0.00399 (D^2Th)^{1.19380}$	.75	.2662	29
Dry weight	$Y = 0.00232 (D^2Th)^{1.19815}$	.76	.2633	29
Bark in crown ≥ 2.0 inches d.o.b.:				
Green weight	$Y = 0.00033 (D^2Th)^{1.33341}$	.83	.2378	29
Dry weight	$Y = 0.00017 (D^2Th)^{1.36417}$	.83	.2375	29
Wood and bark in dead branches:				
Green weight	$Y = 0.00214 (D^2Th)^{0.96298}$	.44	.4460	25
Dry weight	$Y = 0.00143 (D^2Th)^{0.96617}$	.44	.4533	25

$$aY = b_0 (D^2Th)^{b_1}$$

where:

Y = component weight in pounds.

D = d.b.h. in inches.

Th = total tree height in feet.

b₀, b₁ = regression coefficients.

^bStandard error in Log₁₀ form.

^cAdditional statistics for computation of confidence intervals:

$\Sigma(x - \bar{x})^2 = 4.1055$ and $\bar{x} = 3.9785$ for equations based on 29 trees and

$\Sigma(x - \bar{x})^2 = 0.5235$ and $\bar{x} = 4.2471$ for equations based on 17 trees.

Table 7.—Regression equations for estimating above-stump green cubic-foot volume of the total tree and its components for southern red oak trees 5 to 22 inches d.b.h., using d.b.h. and total height as independent variables

Cubic-foot volume (Y)	Regression equation ^a	Coefficient of determination (R ²)	Standard error ^b (S _{y·x}) ^c	Number trees sampled (N)
Total tree (excluding foliage):				
Wood	$Y = 0.000913 (D^2Th)^{1.10025}$	0.98	0.0559	29
Bark	$Y = 0.000318 (D^2Th)^{1.07124}$	.98	.0524	29
Wood & bark	$Y = 0.001220 (D^2Th)^{1.09436}$	.99	.0524	29
Stem from stump to saw-log merchantable top (trees ≥ 11.0 inches d.b.h.):				
Wood	$Y = 0.002805 (D^2Th)^{0.91079}$	.74	.0998	17
Bark	$Y = 0.001801 (D^2Th)^{0.79487}$	.68	.1015	17
Wood & bark	$Y = 0.004113 (D^2Th)^{0.89093}$	.74	.0985	17
Stem from stump to 8-inch d.i.b. top (trees ≥ 11.0 inches d.b.h.):				
Wood	$Y = 0.001072 (D^2Th)^{1.04378}$	.96	.0422	17
Bark	$Y = 0.000688 (D^2Th)^{0.92787}$	.93	.0461	17
Wood & bark	$Y = 0.001570 (D^2Th)^{1.02392}$	.96	.0393	17
Stem from stump to 4-inch d.i.b. top:				
Wood	$Y = 0.000389 (D^2Th)^{1.15821}$	.98	.0606	29
Bark	$Y = 0.000221 (D^2Th)^{1.05965}$	.97	.0775	29
Wood & bark	$Y = 0.000567 (D^2Th)^{1.13994}$	.98	.0611	29
Crown material (all branches and top-wood < 4 inches d.i.b. excluding foliage):				
Wood	$Y = 0.000415 (D^2Th)^{1.03977}$	.79	.2051	29
Bark	$Y = 0.000068 (D^2Th)^{1.12860}$	.89	.1580	29
Wood & bark	$Y = 0.000465 (D^2Th)^{1.06191}$	.82	.1905	29
Crown material ≥ 2.0 inches d.o.b.:				
Wood	$Y = 0.000074 (D^2Th)^{1.17306}$	.75	.2657	29
Bark	$Y = 0.000004 (D^2Th)^{1.35751}$	.83	.2396	29
Wood & bark	$Y = 0.000068 (D^2Th)^{1.21332}$	.77	.2575	29

$$^a Y = b_0 (D^2Th)^{b_1}$$

where:

Y = component volume in cubic feet.

D = d.b.h. in inches,

Th = total tree height in feet,

b₀, b₁ = regression coefficients.

^bStandard error in log₁₀ form.

^cAdditional statistics for computation of confidence intervals:

$\Sigma(x - \bar{x})^2 = 4.1055$ and $\bar{x} = 3.9785$ for equations based on 29 trees and

$\Sigma(x - \bar{x})^2 = 0.5235$ and $\bar{x} = 4.2471$ for equations based on 17 trees.

Table 8.—Regression equations for estimating the above-stump wood and bark green weight for southern red oak trees 5 to 22 inches d.b.h. and tree components, using d.b.h., d.b.h. and height to 4-inch top, and d.b.h. and saw-log merchantable height as independent variables

Weight (Y)	Regression equation ^a	Coefficient of determination (R ²)	Standard error ^b (S _{y·x})	Sample mean of x ^b (\bar{x})	Corrected sums of squares for x ^b $\Sigma(x - \bar{x})^2$	Number trees sampled (N)
Wood and bark in total tree, above stump						
	$Y = 3.08334 (D^2)^{1.28986}$	0.99	0.0506	2.1384	3.0593	29
	$Y = 1.02421 (D^2 H4)^{0.85852}$	.96	.0825	3.7728	6.7502	29
	$Y = 4.11999 (D^2)^{1.06916} (Mh)^{0.29694}$	.95	.0430	—	—	17
Wood and bark in stem from stump to saw-log merchantable top						
	$Y = 6.55544 (D^2)^{1.00903}$	.68	.1110	2.3749	.3935	17
	$Y = 0.68801 (D^2 H4)^{0.82142}$	.74	.1014	4.1079	.6390	17
	$Y = 0.99043 (D^2)^{0.72002} (Mh)^{1.09571}$	.96	.0394	—	—	17
Wood and bark in stem from stump to 4-inch d.i.b. top						
	$Y = 1.71928 (D^2)^{1.33801}$	.98	.0706	2.1384	3.0593	29
	$Y = 0.46633 (D^2 H4)^{0.90814}$	.99	.0407	3.7728	6.7502	29
	$Y = 6.56902 (D^2)^{0.90917} (Mh)^{0.31723}$	.96	.0330	—	—	29
Wood and bark in crown (all branches and topwood < 4-inches d.i.b.)						
	$Y = 0.98186 (D^2)^{1.26423}$	.85	.1801	2.1384	3.0593	29
	$Y = 0.47085 (D^2 H4)^{0.80376}$	.76	.2281	3.7728	6.2502	29
	$Y = 0.09298 (D^2)^{1.51128} (Mh)^{0.33387}$	.81	.1312	—	—	17

$$^a Y = a(D^2)^{b_1} \text{ or } Y = a(D^2 H4)^{b_1} \text{ or } Y = a(D^2)^{b_1} (Mh)^{b_2}$$

where:

Y = component weight in pounds,
D = d.b.h. in inches,
H4 = tree height to 4-inch d.i.b. top in feet,
Mh = saw-log merchantable height in feet,
a, b₁, b₂ = regression coefficients.

^bLog₁₀ form.

Table 9.—Regression equations for estimating the above-stump wood volume of southern red oak trees 5 to 22 inches d.b.h. and tree components, using d.b.h., d.b.h. and height to a 4-inch top, and d.b.h. and saw-log merchantable height as independent variables

Cubic-foot volume (Y)	Regression equation ^a	Coefficient of determination (R ²)	Standard error ^b (S _{y·x})	Sample mean of x ^b (\bar{x})	Corrected sums of squares for x ^b $\Sigma(x - \bar{x})^2$	Number trees sampled (N)
Wood in total tree, above stump						
	$Y = 0.04080 (D^2)^{1.27540}$	0.98	0.0536	2.1384	3.0593	29
	$Y = 0.01376 (D^2H4)^{0.84861}$	.96	.0846	3.7728	6.7502	29
	$Y = 0.05675 (D^2)^{1.06593}(Mh)^{0.26495}$	.94	.0481	—	—	17
Wood in stem from stump to saw-log merchantable top						
	$Y = 0.08004 (D^2)^{1.01638}$	.70	.1086	2.3749	0.3935	17
	$Y = 0.00834 (D^2H4)^{0.82646}$	.75	.0990	4.1079	0.6390	17
	$Y = 0.01310 (D^2)^{0.73948}(Mh)^{1.04979}$	.95	.0443	—	—	17
Wood in stem from stump to 4-inch d.i.b. top						
	$Y = 0.02187 (D^2)^{1.33715}$	.98	.0711	2.1384	3.0593	29
	$Y = 0.00596 (D^2H4)^{0.90710}$	.99	.0440	3.7728	6.7502	29
	$Y = 0.08655 (D^2)^{0.92294}(Mh)^{0.28100}$	.95	.0390	—	—	17
Wood in crown (all branches and topwood < 4 inches d.i.b.)						
	$Y = 0.01373 (D^2)^{1.22278}$	.82	.1924	2.1384	3.0593	29
	$Y = 0.00702 (D^2H4)^{0.77299}$	.72	.2389	3.7728	6.7502	29
	$Y = 0.00105 (D^2)^{1.51487}(Mh)^{0.32265}$	.79	.1404	—	—	17

$$^a Y = a(D^2)^{b_1} \text{ or } Y = a(D^2H4)^{b_1} \text{ or } Y = a(D^2)^{b_1}(Mh)^{b_2}$$

where:

Y = component volume in cubic feet,
D = d.b.h. in inches,
H4 = tree height to 4-inch d.i.b. top in feet.
Mh = saw-log merchantable height in feet.
a, b₁, b₂ = regression coefficients.

^bLog₁₀ form.

COMPUTATION OF CONFIDENCE LIMITS

Tables 6, 7, 8, and 9 contain the standard errors of the estimate, the sample mean of x , and the corrected sums of squares for x for each equation in Log_{10} form. These statistics can be used to calculate approximate confidence limits in pounds or cubic feet by using a modification of Cox's formula (Land 1972) for estimating confidence limits for lognormal means:

$$Y_{U,L} = 10^{\text{Log } Y \pm Z \sqrt{S^2_{y \cdot x} \left[\frac{1}{n} + \frac{(x - \bar{x})^2}{\sum (x - \bar{x})^2} \right] + \frac{S^2_{y \cdot x}}{2(n+1)}}} \quad (8)$$

where:

- $Y_{U,L}$ = upper and lower limits for Y ,
- Y = predicted weight or volume of component from equation (6),
- Z = value from the standard normal table for appropriate confidence level,

- $S_{y \cdot x}$ = standard error of estimate for prediction equation,
- n = number of observations used to develop equation,
- \bar{x} = sample mean of $\log x$ — (from table of equations),
- $\sum (x - \bar{x})^2$ = corrected sums of squares for $\log x$ — (from table of equations),
- x = value of independent variable in \log_{10} form.

Cox's method of approximation sufficiently estimates actual confidence limits when applied to samples with small variances, as occur in the total-tree and stem weight and volume southern red oak data sets. Thus, equation (8) should be used to approximate confidence limits for the single-variable equations presented in this Paper.

Table 10.—Predicted green weight of above-stump total-tree wood and bark for southern red oak trees^a

D.b.h. (inches)	Total height (feet) ^b						
	40	50	60	70	80	90	100
..... Pounds							
WOOD AND BARK ^c							
5	144	185	226	269	312		
6	216	277	340	403	468		
7	305	391	479	568	659		
8	410	526	644	765	887	1,011	
9	533	684	837	994	1,153	1,314	
10	674	864	1,058	1,256	1,458	1,662	1,868
11	833	1,068	1,308	1,553	1,802	2,054	2,310
12	1,011	1,296	1,588	1,885	2,187	2,493	2,803
13	1,209	1,549	1,897	2,252	2,613	2,979	3,349
14		1,827	2,238	2,656	3,081	3,513	3,950
15		2,130	2,609	3,097	3,593	4,096	4,605
16		2,459	3,012	3,575	4,147	4,728	5,316
17		2,814	3,446	4,091	4,746	5,411	6,084
18			3,914	4,646	5,390	6,145	6,909
19			4,414	5,240	6,079	6,930	7,792
20			4,948	5,873	6,814	7,768	8,734
21			5,515	6,547	7,595	8,659	9,735
22			6,117	7,261	8,423	9,603	10,797
WOOD ^d							
5	116	149	182	216	251		
6	174	223	273	324	376		
7	245	314	385	457	531		
8	330	423	519	616	715	815	
9	429	550	674	801	929	1,059	
10	543	696	853	1,012	1,175	1,340	1,506
11	671	861	1,054	1,252	1,453	1,657	1,863
12	815	1,045	1,280	1,520	1,764	2,011	2,262
13	974	1,249	1,530	1,817	2,108	2,404	2,703
14		1,473	1,805	2,143	2,487	2,835	3,188
15		1,718	2,105	2,499	2,900	3,306	3,718
16		1,983	2,430	2,885	3,348	3,818	4,293
17		2,270	2,782	3,303	3,833	4,370	4,915
18			3,159	3,752	4,353	4,964	5,582
19			3,564	4,232	4,911	5,599	6,297
20			3,996	4,744	5,505	6,277	7,059
21			4,454	5,289	6,138	6,998	7,870
22			4,941	5,867	6,808	7,763	8,730

^aBlocked-in area indicates range of data.^bIncludes 1-foot stump allowance.^c $Y = 0.06632 (D^2Th)^{1.11245}$.^d $Y = 0.05262 (D^2Th)^{1.11420}$.

Table 11.—Predicted green weight of wood and bark in saw-log stem to 8-inch d.i.b. or saw-log merchantable top for southern red oak trees^a

D.b.h. (inches)	Total height (feet) ^b					
	50	60	70	80	90	100

..... Pounds

			WOOD AND BARK ^c			
11	618	728	837	945	1,051	1,157
12	723	853	980	1,106	1,231	1,354
13	836	986	1,133	1,279	1,423	1,565
14	956	1,127	1,296	1,463	1,627	1,790
15	1,083	1,277	1,469	1,657	1,844	2,029
16	1,217	1,436	1,651	1,863	2,073	2,280
17	1,358	1,602	1,842	2,079	2,313	2,545
18	1,507	1,777	2,043	2,306	2,565	2,822
19	1,662	1,960	2,254	2,543	2,829	3,113
20	1,823	2,151	2,473	2,791	3,105	3,416
21	1,992	2,349	2,701	3,049	3,392	3,731
22	2,167	2,556	2,939	3,317	3,690	4,059

			WOOD ^d			
11	510	604	696	787	877	967
12	599	709	817	924	1,030	1,135
13	694	822	947	1,071	1,194	1,316
14	796	942	1,086	1,228	1,369	1,509
15	904	1,070	1,233	1,395	1,555	1,714
16	1,019	1,205	1,389	1,571	1,752	1,930
17	1,139	1,348	1,554	1,757	1,959	2,159
18	1,266	1,498	1,726	1,953	2,177	2,399
19	1,399	1,655	1,907	2,157	2,405	2,651
20	1,537	1,819	2,097	2,372	2,644	2,914
21	1,682	1,990	2,294	2,595	2,893	3,188
22	1,833	2,168	2,500	2,827	3,152	3,474

^aBlocked-in area indicates range of data.

^bIncludes 1-foot stump allowance.

^c $Y = 0.23227 (D^*Th)^{0.90557}$.

^d $Y = 0.16578 (D^*Th)^{0.92239}$.

Table 12.—Predicted green weight of wood and bark in stem to 4-inch d.i.b. top for southern red oak trees^a

D.b.h. (inches)	Total height (feet) ^b						
	40	50	60	70	80	90	100
..... Pounds							
WOOD AND BARK ^c							
5	92	119	147	175	205		
6	140	181	224	267	312		
7	200	259	320	382	446		
8	272	353	436	521	608	697	
9	358	464	573	685	799	916	
10	457	592	731	874	1,020	1,169	1,321
11	570	738	912	1,090	1,272	1,458	1,648
12	697	903	1,115	1,333	1,556	1,784	2,016
13	839	1,087	1,343	1,605	1,874	2,148	2,427
14		1,290	1,594	1,906	2,225	2,550	2,881
15		1,514	1,870	2,236	2,610	2,992	3,381
16		1,759	2,172	2,597	3,032	3,475	3,926
17		2,024	2,500	2,989	3,489	3,999	4,518
18			2,854	3,412	3,983	4,565	5,158
19			3,235	3,868	4,515	5,175	5,847
20			3,643	4,356	5,085	5,828	6,585
21			4,079	4,877	5,693	6,526	7,373
22			4,544	5,432	6,341	7,269	8,212
WOOD ^d							
5	74	96	119	143	167		
6	114	148	183	219	256		
7	163	212	262	314	367		
8	223	289	358	429	501	575	
9	294	381	471	564	660	757	
10	375	487	603	722	844	968	1,095
11	469	609	753	902	1,054	1,210	1,368
12	575	746	923	1,105	1,292	1,483	1,677
13	693	900	1,113	1,333	1,558	1,788	2,022
14		1,070	1,324	1,585	1,852	2,126	2,404
15		1,257	1,555	1,862	2,176	2,498	2,825
16		1,461	1,808	2,165	2,531	2,904	3,285
17		1,684	2,084	2,495	2,916	3,346	3,784
18			2,381	2,851	3,333	3,824	4,325
19			2,702	3,235	3,781	4,339	4,908
20			3,046	3,647	4,263	4,892	5,532
21			3,414	4,087	4,778	5,482	6,200
22			3,806	4,557	5,326	6,112	6,912

^aBlocked-in area indicates range of data.

^bIncludes 1-foot stump allowance.

^c $Y = 0.03062 (D^{2.7}Th)^{1.15873}$.

^d $Y = 0.02324 (D^{2.7}Th)^{1.16832}$.

Table 13.—Predicted green weight of wood and bark in crown for southern red oak trees^a

D.b.h. (inches)	Total height (feet) ^b						
	40	50	60	70	80	90	100
..... Pounds							
WOOD AND BARK ^c							
5	44	56	68	81	93		
6	65	83	101	119	138		
7	91	116	141	166	192		
8	121	154	188	222	256	291	
9	156	199	242	286	330	374	
10	196	249	304	358	414	470	526
11	241	306	373	440	508	577	646
12	291	369	450	531	613	696	779
13	345	439	534	631	728	827	926
14		515	627	740	854	970	1,086
15		597	727	858	991	1,125	1,260
16		686	835	986	1,139	1,293	1,448
17		782	952	1,124	1,297	1,473	1,650
18			1,076	1,271	1,467	1,666	1,866
19			1,209	1,428	1,648	1,871	2,096
20			1,351	1,594	1,841	2,090	2,341
21			1,500	1,771	2,045	2,321	2,600
22			1,658	1,958	2,260	2,566	2,874
WOOD ^d							
5	34	43	53	62	72		
6	51	64	78	91	105		
7	70	89	108	127	146		
8	93	118	143	168	193	219	
9	119	151	183	216	248	281	
10	149	189	229	269	310	352	393
11	182	231	280	330	380	430	481
12	219	278	337	396	457	517	578
13	260	329	399	470	541	613	685
14		385	467	549	633	717	801
15		445	540	636	732	829	927
16		510	619	729	839	951	1,063
17		580	704	829	954	1,081	1,209
18			794	935	1,077	1,220	1,364
19			891	1,049	1,208	1,368	1,530
20			993	1,169	1,346	1,525	1,705
21			1,101	1,296	1,493	1,691	1,891
22			1,215	1,430	1,647	1,866	2,086

^aBlocked-in area indicates range of data.^bIncludes 1-foot stump allowance.^c $Y = 0.02596 (D^2Th)^{1.07671}$.^d $Y = 0.02292 (D^2Th)^{1.05855}$.

Table 14.—Predicted volume of above-stump total-tree wood and bark for southern red oak trees^a

D.b.h. (inches)	Total height (feet) ^b						
	40	50	60	70	80	90	100
..... Cubic feet							
WOOD AND BARK ^c							
5	2.3	3.0	3.6	4.3	5.0		
6	3.5	4.5	5.4	6.4	7.5		
7	4.9	6.2	7.6	9.0	10.4		
8	6.5	8.4	10.2	12.1	14.0	15.9	
9	8.5	10.8	13.2	15.6	18.1	20.6	
10	10.7	13.6	16.6	19.7	22.8	25.9	29.1
11	13.1	16.8	20.5	24.3	28.1	31.9	35.8
12	15.9	20.3	24.8	29.3	34.0	38.6	43.4
13	19.0	24.2	29.5	35.0	40.5	46.0	51.7
14		28.5	34.7	41.1	47.6	54.1	60.8
15		33.1	40.4	47.8	55.4	63.0	70.7
16		38.1	46.5	55.1	63.8	72.5	81.4
17		43.5	53.1	62.9	72.8	82.8	92.9
18			60.2	71.3	82.5	93.9	105.3
19			67.8	80.2	92.9	105.6	118.6
20			75.8	89.8	103.9	118.2	132.6
21			84.4	99.9	115.6	131.5	147.6
22			93.4	110.6	128.0	145.6	163.4
WOOD ^d							
5	1.8	2.3	2.9	3.4	3.9		
6	2.7	3.5	4.3	5.0	5.8		
7	3.8	4.9	6.0	7.1	8.2		
8	5.1	6.6	8.0	9.5	11.0	12.5	
9	6.7	8.5	10.4	12.3	14.3	16.2	
10	8.4	10.7	13.1	15.5	18.0	20.5	23.0
11	10.3	13.2	16.2	19.1	22.2	25.2	28.3
12	12.5	16.0	19.6	23.2	26.9	30.6	34.3
13	14.9	19.1	23.3	27.7	32.0	36.5	40.9
14		22.5	27.5	32.6	37.7	42.9	48.2
15		26.2	32.0	37.9	43.9	50.0	56.1
16		30.2	36.9	43.7	50.6	57.6	64.7
17		34.5	42.1	49.9	57.8	65.8	73.9
18			47.8	56.6	65.5	74.6	83.8
19			53.8	63.7	73.8	84.0	94.4
20			60.2	71.4	82.7	94.1	105.7
21			67.1	79.4	92.0	104.8	117.6
22			74.3	88.0	101.9	116.0	130.3

^aBlocked-in area indicates range of data.^bIncludes 1-foot stump allowance.^c $Y = 0.001220(D^2Th)^{1.09436}$.^d $Y = 0.000913(D^2Th)^{1.10025}$.

Table 15.—Predicted volume of wood and bark in stem to 8-inch d.i.b. or saw-log merchantable top for southern red oak trees^a

D.b.h. (inches)	Total height (feet) ^b					
	50	60	70	80	90	100
..... Cubic feet						
WOOD AND BARK ^c						
11	9.6	11.3	13.0	14.6	16.3	17.8
12	11.2	13.2	15.2	17.1	19.0	20.8
13	13.0	15.2	17.5	19.7	21.9	24.0
14	14.8	17.4	20.0	22.5	25.0	27.4
15	16.7	19.7	22.6	25.4	28.2	31.0
16	18.8	22.1	25.3	28.5	31.7	34.8
17	20.9	24.6	28.2	31.8	35.3	38.8
18		27.2	31.2	35.2	39.1	42.9
19		30.0	34.4	38.7	43.0	47.3
20		32.9	37.7	42.5	47.2	51.8
21		35.8	41.1	46.3	51.4	56.5
22		38.9	44.7	50.3	55.9	61.4
WOOD ^d						
11	7.8	9.2	10.6	12.0	13.3	14.7
12	9.1	10.8	12.4	14.0	15.6	17.2
13	10.6	12.5	14.4	16.2	18.1	19.9
14	12.1	14.3	16.5	18.6	20.7	22.8
15	13.7	16.2	18.7	21.1	23.5	25.8
16	15.4	18.2	21.0	23.7	26.4	29.0
17	17.2	20.4	23.4	26.5	29.5	32.4
18		22.6	26.0	29.4	32.7	36.0
19		24.9	28.7	32.4	36.1	39.7
20		27.4	31.5	35.6	39.6	43.6
21		29.9	34.4	38.9	43.3	47.6
22		32.6	37.5	42.3	47.1	51.9

^aBlocked-in area indicates range of data.

^bIncludes 1-foot stump allowance.

^c $Y = 0.004113 (D^2Th)^{0.89093}$.

^d $Y = 0.002805 (D^2Th)^{0.91079}$.

Table 16.—Predicted volume of wood and bark in stem to 4-inch d.i.b. top for southern red oak trees^a

D.b.h. (inches)	Total height (feet) ^b						
	40	50	60	70	80	90	100

..... Cubic feet

WOOD AND BARK^c

5	1.5	1.9	2.4	2.8	3.3		
6	2.3	2.9	3.6	4.3	5.0		
7	3.2	4.1	5.1	6.1	7.1		
8	4.4	5.6	6.9	8.2	9.6	11.0	
9	5.7	7.3	9.0	10.8	12.5	14.4	
10	7.2	9.3	11.5	13.7	16.0	18.2	20.6
11	9.0	11.6	14.3	17.0	19.8	22.7	25.6
12	11.0	14.1	17.4	20.8	24.2	27.7	31.2
13	13.2	17.0	20.9	24.9	29.0	33.2	37.4
14		20.1	24.8	29.5	34.4	39.3	44.3
15		23.5	29.0	34.5	40.2	46.0	51.9
16		27.3	33.6	40.0	46.6	53.3	60.1
17		31.3	38.5	45.9	53.5	61.2	69.0
18			43.9	52.3	60.9	69.7	78.6
19			49.7	59.2	68.9	78.8	88.9
20			55.8	66.5	77.5	88.6	99.9
21			62.4	74.4	86.6	99.0	111.7
22			69.4	82.7	96.3	110.1	124.2

WOOD^d

5	1.2	1.5	1.9	2.2	2.6		
6	1.8	2.3	2.8	3.4	4.0		
7	2.5	3.3	4.0	4.8	5.6		
8	3.4	4.5	5.5	6.6	7.7	8.8	
9	4.5	5.9	7.2	8.7	10.1	11.6	
10	5.8	7.5	9.2	11.1	12.9	14.8	16.7
11	7.2	9.3	11.5	13.8	16.1	18.4	20.8
12	8.8	11.4	14.1	16.9	19.7	22.6	25.5
13	10.6	13.7	17.0	20.3	23.7	27.1	30.7
14		16.3	20.2	24.1	28.1	32.2	36.4
15		19.1	23.6	28.3	33.0	37.8	42.7
16		22.2	27.5	32.8	38.3	43.9	49.6
17		25.6	31.6	37.8	44.1	50.5	57.1
18			36.1	43.1	50.3	57.7	65.2
19			40.9	48.9	57.1	65.4	73.9
20			46.0	55.0	64.2	73.6	83.2
21			51.6	61.6	71.9	82.4	93.2
22			57.4	68.6	80.1	91.8	103.7

^aBlocked-in area indicates range of data.

^bIncludes 1-foot stump allowance.

^c $Y = 0.000567(D^2Th)^{1.13994}$.

^d $Y = 0.000389(D^2Th)^{1.15821}$.

Table 17.—Predicted volume of wood and bark in crown for southern red oak trees^a

D.b.h. (inches)	Total height (feet) ^b						
	40	50	60	70	80	90	100
..... Cubic feet							
WOOD AND BARK ^c							
5	0.7	0.9	1.1	1.3	1.5		
6	1.1	1.3	1.6	1.9	2.2		
7	1.5	1.8	2.2	2.6	3.0		
8	1.9	2.5	3.0	3.5	4.0	4.6	
9	2.5	3.1	3.8	4.5	5.2	5.9	
10	3.1	3.9	4.8	5.6	6.5	7.4	8.2
11	3.8	4.8	5.9	6.9	7.9	9.0	10.1
12	4.6	5.8	7.0	8.3	9.6	10.8	12.1
13	5.4	6.9	8.3	9.8	11.3	12.8	14.4
14		8.0	9.8	11.5	13.3	15.0	16.8
15		9.3	11.3	13.3	15.4	17.4	19.5
16		10.7	13.0	15.3	17.6	20.0	22.3
17		12.2	14.8	17.4	20.0	22.7	25.4
18			16.7	19.6	22.6	25.6	28.7
19			18.7	22.0	25.4	28.7	32.1
20			20.8	24.5	28.3	32.1	35.8
21			23.1	27.2	31.4	35.5	39.8
22			25.5	30.0	34.6	39.2	43.9
WOOD ^d							
5	0.5	0.7	0.8	1.0	1.1		
6	.8	1.0	1.2	1.4	1.6		
7	1.1	1.4	1.7	2.0	2.3		
8	1.5	1.8	2.2	2.6	3.0	3.4	
9	1.9	2.3	2.8	3.3	3.8	4.3	
10	2.3	2.9	3.5	4.1	4.7	5.4	6.0
11	2.8	3.5	4.3	5.0	5.8	6.5	7.3
12	3.4	4.3	5.1	6.0	6.9	7.8	8.7
13	4.0	5.0	6.1	7.1	8.2	9.3	10.3
14		5.9	7.1	8.3	9.6	10.8	12.1
15		6.8	8.2	9.6	11.0	12.5	13.9
16		7.7	9.4	11.0	12.6	14.3	15.9
17		8.8	10.6	12.5	14.3	16.2	18.0
18			11.9	14.0	16.1	18.2	20.3
19			13.4	15.7	18.0	20.4	22.7
20			14.9	17.5	20.1	22.7	25.3
21			16.5	19.3	22.2	25.1	28.0
22			18.1	21.3	24.5	27.6	30.8

^aBlocked-in area indicates range of data.^bIncludes 1-foot stump allowance.^c $Y = 0.000465 (D^2Th)^{1.06191}$.^d $Y = 0.000415 (D^2Th)^{1.03977}$.

Clark, Alexander, III, Douglas R. Phillips, and Harry C. Hitchcock III.

1980. Predicted weights and volumes of southern red oak trees on the Highland Rim in Tennessee. USDA For. Serv., Res. Pap. SE-208, 23 p. Southeast. For. Exp. Stn., Asheville, N.C.

Equations are presented for predicting green and dry weight and green volume of the total tree above stump and its components using d.b.h. and total height, d.b.h. and height to a 4-inch top, d.b.h. and saw-log merchantable height, and d.b.h. alone. Tables developed from equations show weight and volume of the total tree and its components by d.b.h. and total height class.

KEYWORDS: *Quercus falcata* Michx., biomass, component proportions, equations, specific gravity, moisture content, weight per cubic foot.

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